RESEARCH PROJECT SEGMENT

*State:* Alaska

*Project No.:* F-9-3 *Name:* Sport Fish Investigations of Alaska.

*Study No.:* R-11 *Study Title:* A Life History Study of Sheefish and Whitefish in Alaska.

*Period Covered:* July 1, 1970 to June 30, 1971.

## ABSTRACT

Sheefish, Stenodus leucichthys nelma, planted in Four Mile Lake continued to show good growth and survival. Fish sampled in May, 1970, averaged 31 cm in length; those sampled in September averaged 40 cm. All sheefish eggs taken in 1970 died within a week of reaching the Fire Lake Hatchery and the fry of the 1969 egg take were accidentally killed in the Clear Rearing Pond. A survey of the Imuruk Basin and its tributary rivers on the Seward Peninsula during July, 1970, indicates that this area would support a naturally reproducing population of sheefish.

Upper Yukon River streams and the Koyuk River on Norton Sound were surveyed for presence of sheefish spawning areas.

A preliminary survey of the Porcupine River in August, 1970, indicated that the river is both a spawning and rearing stream for sheefish. Sheefish of age classes 0, I, II, and III were taken 90 miles up the Porcupine River.

Data is presented on sheefish and whitefish sport and subsistence utilization from Minto Flats and the Kobuk-Selawik area.

Taxonomic history of whitefish, Coregonus sp. sensu latu, is reviewed. Meristic data is presented on Arctic cisco, Coregonus autumnalis; least cisco, C. sardinella ; humpback whitefish, C. pidschian; broad whitefish, C. nasus; and round whitefish, Prosopium cylindraceum, from various Alaskan populations.

Preliminary data on whitefish distribution is given. An age and growth study of humpback whitefish and least cisco from the Chatanika River indicates more rapid growth than from other areas in Alaska. Least cisco first mature at ages II and III.

## RECOMMENDATIONS

1. Expand effort in sheefish egg takes. Continue to search for new waters suitable for introduction of sheefish.

2. Continue the search for the spawning grounds of Kuskokwim River sheefish.

3. Initiate preliminary surveys of rivers of the middle Yukon drainage prior to a large-scale research program in this area in 1972.

4. Conduct a comprehensive sheefish food habits study encompassing a period of one year on the Kuskokwim River population.

5. Conduct a statistically based creel census on the Holitna River.

6. Continue the whitefish research on taxonomy and distribution. Initiate age and growth studies on broad whitefish from major drainages in Alaska.

## TECHNIQUES USED

In the Imuruk Basin survey, fish populations were sampled using graduated mesh gill nets. Bottom samples were taken with a Petersen dredge and will be analyzed by the Institute of Marine Science which also analyzed the water samples for salinity and nutrients.

Sheefish were collected by hook and line, electroshocking unit, and gill nets of 5- and 5 1/2-inch stretch mesh. Sheefish of ages 0, I, and II were collected by graduated mesh gill net.

Sheefish aerial surveys were flown with a Helio Courier aircraft.

Data on subsistence and commercial utilization of sheefish and whitefish in the Kotzebue and Kobuk river area were provided by the Division of Commercial Fisheries. Scale samples of Chatanika River whitefish were collected from a weir operated in 1968. This selected sample was intended to include all size groups.

Fish for taxonomic studies were collected by grayling and North Slope project personnel, in addition to those collected in the course of the sheefish-whitefish investigations.

Specimens were preserved and analyzed in the Fish and Game laboratory, except some gill raker counts were made in the field on large specimens of broad whitefish and humpback whitefish from the Porcupine River and Minto

Flats. The first left arch was excised and all gill rakers, including rudimentary ones, were counted. Gill rakers of ciscoes and smaller broad and humpback whitefish were counted with the aid of a dissecting scope.

Morphological measurements were taken on many whitefish specimens. These data will be presented in future segment reports.

## FINDINGS

### *Job R-II-A Sheefish Lake and River Adaptability Study.*

#### Objectives

1. To find a method of rearing sheefish to fingerling size.
2. To follow the progress of previous sheefish plants.
3. To survey new lakes, estuaries, and streams to determine their suitability for sheefish.

#### Sheefish Stocking

A rearing pond was constructed in 1969 on the Clear Air Force Site using water from the power plant cooling system. This pond with dimensions of 200' x 40' had a water depth of three feet when stocked with 50,000 sheefish fry on February 12, 1970.

All sheefish were killed by a power plant discharge of 60 gallons of 25% sodium hydroxide on March 15. On March 17, the pH of the pond was 12.

Forty-four sheefish averaging 14 cm in fork length were planted in Engineer Hill Lake on Eielson Air Force Reservation in July, 1970. These fish were from the 1968 Chatanika River egg take and had been kept in Fire Lake Hatchery aquaria for over one year. Engineer Hill Lake has a population of chubs, Couesius plumbeus, and was stocked with 20,000 grayling fry, Thymallus arcticus, in 1968, and 25,000 in 1970.

Sheefish stocked in Four-Mile Lake near Tok continue to show excellent growth and survival. Twenty-three sheefish were taken on May 20, in two net nights, and 21 fish were taken in early September in one net night.

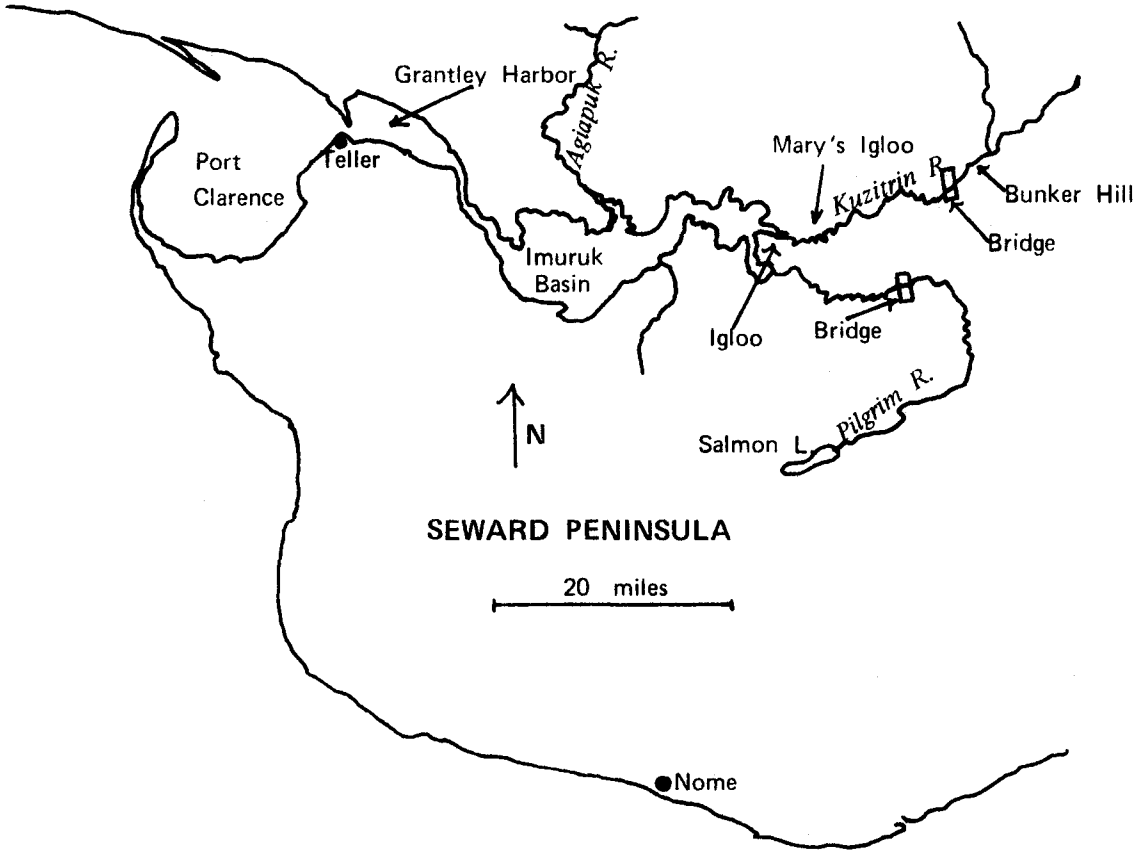


FIGURE 1 IMURUK BASIN, ALASKA.

All fish were age group II. Evidently, the 1969 plant did not survive, as no age I sheefish were captured. The mean length of the fish taken in May was 31 cm, and those taken in September averaged 40 cm. Data from the past two years indicate that 80% of the annual sheefish growth in Four-Mile Lake.

Sport fishing for sheefish in Four-Mile Lake was unsuccessful in 1970.

## Egg Take

The 1970 sheefish egg take was scheduled for the Holitna River; however, no spawning fish were found there up to September 28. The Kobuk and Koyukuk rivers were frozen over by September 29, preventing any egg takes in these rivers. The electrofishing boat was used on the Chatanika River on September 30 and October 1, but only 15 sheefish were taken and most of these had already spawned. Approximately 90,000 eggs were taken from one female by caeserian. Although the eggs reached the Fire Lake Hatchery in good condition, all died within one week. The mortality may have been due to the unripe eggs.

## Imuruk River Survey

The Port Clarence-Grantley Harbor-Imuruk Basin area and its tributaries were surveyed in July to determine the feasibility of stocking sheefish.

This area lies in an east-west direction in the Teller area of the Seward Peninsula at 65°05' to 65°10'N Lat. and 165°15' to 166°45'W Long. (Figure 1). Port Clarence is a marine environment as shown by its fauna and salinity. Grantley Harbor is separated from Port Clarence by Teller Spit and could be considered a brackish water environment although the salinity is 23 ppt.

Salinity and nutrient values for the Imuruk Basin area are as follows:

| | Salinity (ppt) | $NH_3$ µg-at/L | $NO_2$-N µg-at/L | $NO_3$-N µg-at/L |
|---|---|---|---|---|
| Port Clarence (Teller) | 28.5 | 3.2 | 0.04 | 0.4 |
| Port Clarence (Pt. Spencer) | 29.7 | 12.0 | 0.05 | 0.1 |
| Grantley Harbor (Teller) | 23.4 | 3.2 | 0.04 | 0.6 |
| Grantley Harbor (Tuksuk) | -- | 9.8 | 0.04 | 0.6 |
| Lower Imuruk Basin | 5.4 | 2.6 | 0.06 | 0.6 |
| Upper Imuruk Basin | 3.8 | 4.1 | 0.06 | 0.6 |

TABLE I Results of Test Netting, Imuruk Basin Area, July, 1970.

| Location | Net Nights | Fish Captured* | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PS | CS | RS | AC | ACi | LCi | HWF | BWF | RWF | SM | GR | S | BB | NP |
| Port Clarence-Teller | 2 | 22 | | | 2 | 19 | 7 | 1 | | | | | | | |
| Grantley Harbor - Reindeer Corral | 2 | 19 | 1 | | | 15 | 57 | 9 | | | | | | | |
| Imuruk Basin | 2 | | | | | | 51 | 6 | 9 | | | | | | 7 |
| Agiapuk - 5 miles upstream | 2 | 5 | 1 | | 1 | 1 | 96 | 3 | 1 | 5 | | 4 | | 1 | |
| Agiapuk mouth | 2 | 54 | | | 1 | 4 | 164 | 24 | 6 | 6 | 2 | | | | |
| Kuzitrin - Pilgrim Delta | 1 | | 1 | 1 | | | 2 | | | | | | | | 1 |
| Lower Kuzitrin - Igloo | 2 | | | | | | 3 | 3 | 1 | | | | 3 | | |
| Lower Pilgrim | 1 | 4 | 1 | | | | 24 | 1 | | | | | | | |
| Salmon Lake (Pilgrim System) | 5 | | | 3 | 3 | | 20 | | | 35 | | 1 | | | |

* PS - Pink Salmon
CS - Chum Salmon
RS - Red Salmon
AC - Arctic Char
ACi - Arctic Cisco
LCi - Least Cisco
HWF - Humpback Whitefish
BWF - Broad Whitefish
RWF - Round Whitefish
SM - Smelt
GR - Grayling
S - Sucker
BB - Burbot
NP - Northern Pike

Imuruk Basin is connected to Grantley Harbor by the eight-mile-long Tuksuk Channel. Tuksuk Channel has some of the deepest water in the area (up to 84 feet) and is subject to changes in water level due to wind and tides. Imuruk Basin, locally called "Salt Lake", is approximately 15 miles long by 8 miles wide. The Kuzitrin and Pilgrim rivers drain into Imuruk Basin from the east, the Agiapuk River from the north, and the Cobblestone River from the south. Imuruk Basin is 12 feet deep throughout most of its area. The bottom is silt and clay and is poor in volume and species of organisms compared to Grantley Harbor. However, the plankton volume is much greater in the Imuruk Basin than Grantley Harbor. The Imuruk Basin water was dark green due to the high concentration of blue-green algae.

A list of the fish species taken during the Imuruk Basin survey is presented in Table 1. In addition to the freshwater fish, the saffron cod, Eleginus gracilis, and white spotted greenling, Hexagrammos stelleri, flounders (three species), and cottids (three species) were taken in Port Clarence and Grantley Harbor. The cottids and flounders, as well as herring, Clupea harengus pallasi, were also taken by gill net in Imuruk Basin and the lower Agiapuk River.

Seining near Igloo in the Kuzitrin River took ninespine stickleback, Pungitius pungitius, least cisco, Coregonus sardinella, and round whitefish, Prosopium cylindraceum. The majority of the least cisco taken by experimental gill net in the Imuruk Basin area were 18 - 24 cm in length, similar in size to least cisco found in stomachs of Selawik Lake sheefish.

Surface water temperatures at all stations ranged from 54° - 56°F (12.2° - 13.3°C), except four miles up the Agiapuk River where it was 60°F (15.6°C). The common mouths of the Kuzitrin and Pilgrim rivers comprise an extensive delta system with slow moving water and a series of interconnected sloughs and lakes. A large part of the delta system has heavy growth of submergent and floating vegetation.

The section of river from the Pilgrim River bridge to Pilgrim Hot Springs (10 river miles) has many areas with the right combination of gravel, water velocity, and depth to be suitable for sheefish spawning. Most of these gravel bars, however, are quite small in size. Only one area above the Pilgrim River bridge was found to contain suitable spawning gravel.

The Kuzitrin River is longer and has a greater flow than the Pilgrim River, but has less mountainous surrounding topography. As with other Seward Peninsula streams, the water is very clear and large gravel bars with no trees are present along its middle and upper courses. The Kuzitrin River contained only a few areas of suitable spawning habitat, mainly due to slow water current and uniformly sized small gravel. These spawning areas are located downstream from the Kuzitrin River Bridge and between Bunker Hill and the Kugarok River confluence. Above the Kugarok River, the Kuzitrin River current is very slow.

The Agiapuk River has a smaller delta area than the Pilgrim-Kuzitrin delta, but has a gravel bottom even in the lower reaches. No suitable spawning grounds were found in the lower seven miles of the Agiapuk River but they may exist farther upstream.

The Imuruk Basin area is similar biologically and physically to the Selawik Lake area. Imuruk Basin is slightly brackish, fairly shallow, and has three major rivers flowing into it. These rivers have extensive delta areas with considerable amounts of slow moving water and interconnected lakes and sloughs. These deltas are important as rearing areas. Five whitefish species are present, with the least cisco being the most abundant. The shrimp, Gammarus sp., and the isopod, Mesidotea entonon, both items of sheefish diet in Selawik Lake, are present in the basin. Suitable spawning grounds are available in the Kuzitrin and Pilgrim rivers near the bridges on the Kugarok Road and possibly in the Agiapuk River. Sheefish would be available to the sportsman from the highway system in Imuruk Basin via a boat trip from Teller and from the Kuzitrin and Pilgrim bridges. Sheefish stocked in the Imuruk Basin would probably not be able to ascend the rapids of the upper Pilgrim River to reach Salmon Lake. Therefore, the only predation on salmon would occur when the smolts are migrating to the ocean. Sheefish would probably be taken by subsistence fishermen during the winter at Mary's Igloo.

It is recommended that sheefish fingerling be stocked in Imuruk Basin, preferably in the area near New Igloo at the junction of the Kuzitrin and Pilgrim rivers. The chances of these fish establishing a naturally reproducing population are excellent. The Port Clarence-Grantley Harbor areas are probably too saline for sheefish and it is recommended that they not be stocked near Teller.

*Job R-II-B Spawning Habits of Sheefish in Alaska.*

## Objectives

1. To determine spawning areas, spawning time, and to observe spawning behavior of Holitna River sheefish.

2. To enumerate spawning populations on the Koyukuk, Kobuk, and Holitna rivers.

## Holitna River Survey

Two weeks were spent on the Holitna River in late September in an effort to locate the sheefish spawning population. Gill nets were set in many locations in an area of 45 - 60 miles upstream in the Holitna, but no sheefish were taken. This area contains the only gravel suitable for sheefish. Water temperature was 38°F (3.3°C) on September 24. Aerial surveys were flown on September 28, but no sheefish were observed.

## Koyukuk River Survey

The Koyukuk River from Hughes to Allakaket and the Alatna River from Allakaket to Siruk Creek were surveyed by plane on September 6. The waters of both streams were high and turbid and no fish were observed.

## Kobuk River Survey

Aerial surveys of the Kobuk River spawning population were flown on September 6, and 3,220 sheefish were enumerated. This figure compares with 4,973 for 1968 and 3,654 for 1969.

An attempt was made to estimate the Kobuk River spawning population by using the Petersen tag-and-recapture method. From September 4 - 12, 124 sheefish were tagged on the spawning grounds 26 miles above Kobuk. From September 12, until mid-October, 4,753 sheefish on their downstream migration were taken by subsistence fishermen, including 32 of the fish tagged on the spawning ground (25.8%). Using the Petersen formula, the total spawning population is 17,864. This figure is obviously too high. A closer examination of the catch reveals that the villages of Noorvik, and possibly Kiana, harvest a high percentage of immature and non-spawning fish which have spent the summer in the lower part of the Kobuk River.

| Village | Miles Upstream | Downstream Subsistence Catch | Tags Recovered |
|---|---|---|---|
| Kobuk | 226 | 105 | 5 |
| Shungnak | 216 | 193 | 2 |
| Ambler | 159 | data not available | - |
| Kiana | 60 | 466 | 1 |
| Noorvik | 34 | 3,986 | 24 |

A more realistic figure for the subsistence catch of downstream post-spawning fish would be 2,000. This would place the estimate of the spawning population at 7,130.

If the Petersen estimate is to be used again, it will be necessary to determine accurately the catch of immature or non-spawning sheefish at Kiana and Noorvik.

*Job R-II-C* *Movements, Age and Growth, and Population Dynamics of Sheefish in the Upper Yukon River, Seward Peninsula-Norton Sound Streams.*

## Objectives

1. To determine the location, abundance, and run timing of sheefish in the Porcupine, Nation, Kandik, Ray, and Dall rivers.

2. To determine age and growth, food habits, and migratory habits of sheefish in these rivers.

## Upper Yukon Drainage

Gill nets set at the mouths of the Charley, Kandik, Nation, Tatonduk, and Seventymile rivers in mid-June (28 net nights) took seven sheefish ranging in length from 48 - 66 cm. No sheefish were taken by hook and line, nor were any young sheefish taken by seine in the delta areas of these rivers in 1970.

Sheefish evidently are present near the mouths of these upper Yukon River tributary streams from breakup until freezeup (Alt, 1965; 1969). Sheefish in this area belong to a local population which probably overwinters in the upper Yukon River vicinity. They are the slowest growing of all Alaskan populations (Alt, 1969).

Since sheefish of age groups 0 and I were taken in the delta areas of all five upper Yukon River tributaries in the summer of 1964, it can be assumed that spawning occurs in these rivers. In 1964, a pre-spawning female was taken at the mouth of the Charley River on September 4.

During June, 1970, the five upper Yukon River tributaries were investigated for suitable sheefish spawning habitat. The Charley River was surveyed for 50 miles upstream, and probable sheefish spawning grounds were found in the lower 10 miles of the river. Round whitefish and grayling were found in the upper reaches of the river. The Kandik River was floated for 125 miles from the Canadian border to the mouth. Possible spawning grounds were located in various areas in the lower 40 miles of the river. The rapids of Johnson Gorge (mile 40) would probably block further upstream migration of sheefish, although salmon could negotiate these rapids. A list of the fish species taken by gill net in the Kandik River is given in Table 2. In addition, young chum salmon, Oncorhynchus keta; king salmon, O. tshawytscha; round whitefish; humpback whitefish, C. pidschian; burbot, Lota lota; suckers, Catostomus catostomus; chubs; parasitic Arctic lampreys

(adults), Lampetra japonica; trout perch, Percopsis omiscomaycus; northern pike, Esox lucius; least cisco; slimy scuplins, Cottus cognatus; and grayling were taken by seine at the mouth of the Kandik River.

TABLE 2 Fish Captured (By Graduated Gill Net), Kandik River, June, 1970.

| Area | Date | Net Nights | Fish Captured* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | GR | SF | RWF | HWF | LCi | S | NP |
| 95 miles upstream | 6/12 | 1 | 21 | | 1 | | | | |
| 65 miles upstream | 6/13 | 1 | 9 | | 7 | | | | |
| 40 miles upstream | 6/14 | 1 | 10 | | | | | 12 | 1 |
| 1 mile upstream | 6/15 | 2 | 6 | | | 2 | 2 | 1 | 4 |
| Mouth | 6/16, 6/23-24 | 10 | | 4 | | | 1 | 5 | 6 |

* GR - Grayling
SF - Sheefish
RWF - Round Whitefish
HWF - Humpback Whitefish
LCi - Least Cisco
S - Sucker
NP - Northern Pike

The Nation River was not surveyed in 1970 because of flood conditions, but 1964 surveys indicated presence of gravel suitable for sheefish spawning in the area below Hard Luck Creek (Alt, 1965).

The Tatonduk River was surveyed from the mouth to beyond the forks in Canada. This upper area contains many rapids and the bottom is composed of rocks. The only suitable spawning grounds would be located in the lower eight to nine miles.

The Seventymile River was surveyed only in the lower 10 miles, but a few possible spawning grounds were found.

The short surveys carried out previously on sheefish in the upper Yukon River at various times during the summer indicate that the spawning population is quite small and would not support an intensive sport fishery. It appears that sheefish are most abundant and can be taken by sport fishing gear at the mouths of these five clear water rivers in late July and early August.

It is recommended that no further studies be initiated on these stocks unless future sport fishing utilization warrants it. Samples for electrophoretic analysis of protein may be needed to settle the question of the relationship between upper Yukon and Porcupine river sheefish.

## Porcupine River

A survey of the Porcupine River was made between August 18 and 26, 1970. Gill nets were set at the mouth of the Porcupine River at the mouth of the Black River, and at Ward Camp, 90 miles up the Porcupine River. Table 3 gives the catch of sheefish and other species from the Porcupine River. The capture of sheefish of age groups 0, 1, and 11, 90 miles upstream indicates that the Porcupine River is both a spawning and rearing stream. The capture of these young fish also validated the back calculation method of determining length at the end of each year of life. The Porcupine River, up through the Lower Ramparts, is a wide, slow moving river with gravel bottom and shores. Since the river is so slow moving, the gravel is usually covered with a fine layer of silt and would be unsuitable for sheefish spawning. No females in spawning condition were taken, but 11 mature females were captured that had tiny eggs and would not spawn in 1970. Two males in spawning condition were taken at Ward Camp and two at the Black River mouth. Spawning females may have been farther up the Porcupine or the Black in the area of the spawning grounds at the time of the collecting trip. Preliminary analysis of age and growth data indicate growth similar to sheefish of the Upper Yukon population. It is hoped that future tagging studies and electrophoretic protein analysis will define relationships between the sheefish in the Porcupine and those in the upper and middle Yukon.

Porcupine River sheefish will probably support a small sport fishery. In addition to sheefish, large numbers of trophy sized pike are available. Further research on the summer run timing, spawning areas, and age and growth is recommended for 1971.

## Koyuk River

The entire Koyuk River, which drains into Norton Sound, was surveyed by air on July 26. No gravel or bottom conditions suitable for sheefish spawning were observed in the main stem of the Koyuk. The only possible spawning areas are located in the Koyuk tributaries, the Peace River, and East Fork River. According to Koyuk residents, this sheefish population overwinters in Koyuk Bay and moves upstream after breakup. They report catching up to seven a day in June in subsistence gill nets.

TABLE 3 Fish Taken by Gill Net, Porcupine River, August, 1970.

| Area | Date | Net Nights | Fish Captured* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CS | SF | BWF | HWF | LCi | RWF | GR | NP | BB |
| Black River Mouth | 8/18-19 | 2 | 2 | 4 | | | | | | 10 | |
| Mile 35 - Porcupine River | 8/19 | 1 | | | | 1 | | | | | |
| Sheenjek River Mouth | 8/19 | 1 | | | | | | 1 | | | |
| Ward Camp - Mile 90** | 8/20-23 | 15 | 1 | 22 | 15 | 11 | 2 | | 2 | 35 | 1 |
| Black River Mouth | 8/24 | 3 | | 6 | | 1 | | | | 6 | |
| Porcupine River Mouth | 8/25 | 1 | | 1 | | 2 | 2 | | | 2 | |

* CS - Chum Salmon
SF - Sheefish
BWF - Broad Whitefish
HWF - Humpback Whitefish
LCi - Least Cisco
RWF - Round Whitefish
GR - Grayling
NP - Northern Pike
BB - Burbot

**Also took one sheefish-humpback whitefish hybrid.

Gill nets set in the Lower Koyuk River on July 26 and 27, took two sheefish, a 2.0 kg (age V, 55 cm) mature male, and a 5.5 kg (age VII, 78 cm) nonspawning female. Table 4 gives the results of test netting in the Lower Koyuk River. Sheefish and Arctic ciscoes were feeding on ninespine stickleback. Salinity was 8.5 ppt four miles up the Koyuk River.

TABLE 4 Results of Test Netting Four Miles Up Koyuk River, July 26-28, 1970.

| Net Nights | Fish Captured* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PS | CS | AC | SF | ACi | LCi | HWF | BWF | RWF | SM | NP | FI |
| 2 (graduated mesh nets) | 4 | | 4 | | 22 | 15 | 17 | 1 | 2 | 32 | | 6 |
| 4 (5 1/2-inch nets) | 10 | 6 | 2 | 2 | | | | 2 | | | 4 | |

*PS - Pink Salmon
CS - Chum Salmon
AC - Arctic Char
SF - Sheefish
ACi - Arctic Cisco
LCi - Least Cisco
HWF - Humpback Whitefish
BWF - Broad Whitefish
RWF - Round Whitefish
SM - Smelt
NP - Northern Pike
FI - Flounder

*Job R-II-E Sheefish-Whitefish Utilization.*

Objectives

1. To determine angler use and harvest.
2. To determine trends in the subsistence and commercial fisheries.

Minto Flats

Data collected during a pike creel census program in the Minto Flats indicated a sheefish sport catch of 25 fish. This catch was considerably lower than in previous years and probably reflects the adverse weather conditions in the Flats in 1970. The subsistence take of sheefish in the Flats by New Minto natives was approximately 100. The permanent relocation of New Minto village on the Tolovana River and the completion of a road to the village from the Elliott Highway will result in increased sport and subsistence fishing pressure. The fall sheefish sport catch on the upper Chatanika River was at least 10.

In 1970, the Minto residents took 1,000 - 1,500 broad whitefish averaging about five pounds (2.4 kg) each. Sport anglers took humpback whitefish, least cisco, and round whitefish in August and September in the upper Chatanika River. In October approximately 400 of these three species were taken in the Chatanika River spear fishery.

Kobuk-Selawik

The major utilization of sheefish in the Kobuk River-Selawik area continues to be subsistence. The 1970 Kobuk River subsistence catch was 9,000 including:

| | Fish Caught on Migration | |
|---|---|---|
| | Upstream | Downstream |
| Noorvik | 3,140 | 3,986 |
| Kiana | 324 | 466 |
| Ambler | 125 | * |
| Shungnak | 608 | 193 |
| Kobuk | 50 | 108 |
| | 4,247 | 4,754 |

*Data not available.

The downstream migrant catch in the upstream villages of Kobuk and Shungnak would have been greater but an early freezeup cut short the fishing season. The Selawik Lake subsistence ice fishing catch in April and May was 6,010. Probably an additional 4,000 - 6,000 were caught the remainder of the year. Catch records on the Kotzebue subsistence fishery are incomplete and show only 3,250 fish taken in Hotham Inlet.

The Kotzebue commercial sheefish fishery took 460 fish from October, 1969, to May, 1970, in Hotham Inlet.

The 1970 sport catch for the Kobuk River, Selawik area, and Kotzebue was again less than 500 fish. There is good sport fishing potential for sheefish in April and May through the ice and in open water from June through September at both Selawik Lake and the Kobuk River. Advertising and transportation seem to be the main problems.

According to Kobuk River residents, 1970 was one of the best whitefish years they could remember. A catch of 54,850 was recorded including 20,350 at Noorvik, 6,000 at Kiana, 4,000 at Ambler, 16,500 at Shungnak, and 8,000 at Kobuk. The catch would have been about one-third greater had it not been for the early freezeup. The majority of the catch is composed of humpback whitefish averaging slightly less than two pounds (1 kg) each, but some broad whitefish, least cisco, and round whitefish are taken.

Sheefish and whitefish subsistence and sport catch data from the Koyukuk, lower Yukon, Kuskokwim, and Holitna rivers are fragmentary and will not be included in this report.

*Job R-II-F* *Distribution, Movements, Age and Growth, and Taxonomic Status of Whitefish (Coregonus sp.) in the Tanana-Yukon Drainage and North Slope.*

## Objectives

1. To determine species composition of Interior Alaska waters.
2. To determine age, growth, and age at sexual maturity.
3. To clarify the taxonomic status of various members of Coregonus sp. in the Tanana-Yukon drainage and North Slope streams.

## Taxonomy

Current literature sources give the number of whitefish species in Alaska at from six to nine, excluding the sheefish. Acceptable names for these six are: round whitefish, Prosopium cylindraceum (Pallas); pygmy whitefish, P. coulteri (Eigenmann and Eigenmann); least cisco, C. sardinella Valenciennes; Arctic cisco, C. autumnalis (Pallas); broad whitefish, C. nasus (Pallas); and humpback whitefish, C. pidschian (Gmelin). The Arctic cisco is sometimes divided into two species and the humpback whitefish into three species.

### Genus Prosopium:

Most taxonomists now agree that the round and pygmy whitefish belong to a separate genus, Prosopium, as they are distinguished from the members of the genus Coregonus by the single flap between the nostrils, the presence of parr marks in young fish, lack of interbreeding with other whitefish, and various osteological differences (Gasowska, 1960; Norden, 1961; Shaposhnikova, 1968). The round whitefish is widely distributed in Siberia and northern Alaska. Nikolsky, et. al. (1970), mentioned that the North American form may be a subspecies, P. cylindraceum quadrilateralis (Richardson) which has fewer lateral line scales (86 - 88) and fewer gill rakers (16 - 18). His designation may not be valid as lateral line scale counts and gill raker counts of Alaskan samples overlap with Siberian counts. The pygmy whitefish in Alaska is restricted to Bristol Bay and possibly Kuskokwim Bay. The mountain whitefish, P. williamsoni (Girard), may be found in the lower Sitkine River in Southeast Alaska, but no valid reports are available.

Round whitefish mean gill raker counts for Salmon Lake and Sagavanirktok River fish were 15.9 and 17.9, respectively.

Genus Coregonus - The Ciscoes:

The ciscoes were placed in the genus Leucichthys by earlier taxonomists. Now they are given subgeneric rank in the genus Coregonus. The least cisco is found in the Arctic Ocean drainages in Siberia and is closely allied with C. albula of Western Europe. It has numerous local forms. It can be recognized by the falcate dorsal fin, black tipped pectoral and pelvic fins, and projecting lower jaw. Bean (1889) named C. pusillus from Alaska but this species was found by Dymond (1943) to be conspecific with C. sardinella. Least cisco taxonomic data collected during 1969 and 1970 are presented in Table 5. These limited data indicate one species of cisco with normal variation.

TABLE 5 Gill Raker Counts of Alaskan Least Cisco, 1970.

| Location | n | $\bar{x}$ | Range | S.D. |
|---|---|---|---|---|
| Colville River | 10 | 43.9 | 41 - 47 | 1.8 |
| Imuruk Basin | 11 | 47.3 | 45 - 50 | - |
| Chatanika River | 38 | 42.9 | 36 - 52 | 3.9 |
| Upper Yukon | 4 | 44.6 | 43 - 45 | 2.1 |

The Arctic cisco, called "omul" or "salmon herring" in Siberia, enters all northern rivers from the Mezen on the west to Alaskan and Canadian rivers on the east. It can be recognized by the terminal mouth and the white pectoral and pelvic fins. The body form is not deep and rather oblong. In Alaska, the Arctic cisco has lower gill raker counts than the least cisco. Scofield (1899) named this species Agyrosomus alascanus from Point Hope and Bean (1882) named the Arctic cisco Leucichthys laurettae from specimens collected at Point Barrow. Many authors, e.g., Dymond (1943), Andriyashev (1954), and Walters (1955) consider these synonyms of C. autumnalis. However, McPhail (1966) considered the Arctic cisco in the Bering and Chukchi seas and Point Barrow to be a valid species, C. laurettae (Bean), because of its significantly lower gill raker counts than C. autumnalis.

In 1970, Arctic cisco were collected from the Colville River, Imuruk Basin-Grantley Harbor area, Koyuk River, and Yukon River at Fort Yukon. The gill raker counts are given in Table 6. These data indicate significant differences in counts between the Colville River and Bering Sea forms. It is possible that future collections will minimize the two distinct peaks. Walters (1955) gives the gill raker variation in American C. autumnalis as 33 - 50, and Eurasian C. autumnalis as 35 - 51, and considers this as normal variation in a widely distributed whitefish species.

TABLE 6 Gill Raker Counts of Alaskan Arctic Cisco, 1970.

| Location | n | $\bar{x}$ | Range | S.D. |
|---|---|---|---|---|
| Colville River | 10 | 42.1 | 41 - 44 | 1.10 |
| Imuruk Basin | 21 | 33.8 | 31 - 36 | 1.50 |
| Koyuk River | 7 | 36.6 | 34 - 40 | 2.40 |
| Yukon River | 5 | 34.4 | 33 - 37 | 1.52 |

In Alaska the high and low numbered gill raker forms are similar in appearance and probably in their biology. From a management standpoint, until further evidence is gathered, it may be best to call all Arctic cisco in Alaska C. autumnalis.

Genus Coregonus - The Whitefish:

The broad whitefish, called "chir" in Russia, is a fairly stable species over its entire Russian, Alaskan, and Canadian range. They can be distinguished by the small head, blunt rounded snout, and small eye. The short and broad upper jaw extends forward. Short gill rakers are characteristic; the longest gill raker is contained in the standard length 77 to 100 times; the humpback whitefish value is below 70. Lindsey (1962) further describes this separation. The broad whitefish was referred to as C. kennicotti by earlier authors (Murdoch, 1885; Townsend, 1887), and C. nasus kennicotti by Wynne-Edwards (1952). Gill raker counts for Alaskan broad whitefish collected during past seasons are given in Table 7, and are well within the range of variation of Eurasian C. nasus.

TABLE 7 Gill Raker Counts of Alaskan C. nasus, 1970.

| Location | n | $\bar{x}$ | Range | S.D. |
|---|---|---|---|---|
| Colville River | 15 | 20.1 | 19 - 21 | .99 |
| Minto Flats | 20 | 21.5 | 20 - 23 | 1.28 |
| Imuruk Basin | 11 | 20.6 | 19 - 22 | .81 |

The humpback whitefish, called "sig" in Russia, is in a very confused taxonomic state. The high polymorphism of this fish is due to its inhabitation of many different environments. Berg (1948) subdivided the species into 57 different forms. Current taxonomists tend to lump many of the forms of humpback whitefish.

Early records of humpback whitefish in Alaska have all been as C. nelsoni (Bean). These were mainly coastal fish and had mean gill raker counts of around 20.7 with a range of 16 - 23. This is the same gill raker range as C. lavaretus pidschian found in Siberia east of the Ob River. There are some populations of C. lavaretus pidschian in the lower Ob with gill raker ranges of 18 - 25. So, C. nelsoni could be considered a synonym of C. lavaretus pidschian.

Walters (1955) and Nikolsky, et. al. (1970), have called the humpback form in Alaska C. lavaretus pidschian. McPhail and Lindsey (1970) regard the humpback form in Alaska with 19 - 23 gill rakers as C. pidschian. Populations sampled in Interior Alaska in 1970 were noted to have high mean gill raker counts (Table 8). The Crosswind Lake specimens in the Copper River drainage have the highest gill raker counts in Alaska.

TABLE 8 Gill Raker Counts of Alaskan Humpback Whitefish, 1970.

| Location | n | $\bar{x}$ | Range | S.D. |
|---|---|---|---|---|
| Colville River | 15 | 21.7 | 20 - 23 | .82 |
| Imuruk Basin | 11 | 21.9 | 20 - 23 | 1.13 |
| Chena River | 8 | 22.8 | 21 - 25 | 1.50 |
| Porcupine River | 6 | 23.2 | 22 - 24 | .94 |
| Upper Yukon River | 6 | 23.3 | 23 - 24 | -- |
| Kobuk River | 8 | 23.8 | 22 - 25 | -- |
| Chatanika River | 24 | 24.3 | 23 - 27 | -- |
| Healy Lake | 2 | 24.5 | 24 - 25 | -- |
| Crosswind Lake | 16 | 25.5 | 25 - 27 | .63 |

Walters gave the mean count of a closely allied species C. clupeaformis as not less than 25 (range 24 - 33). Some would argue that the Crosswind Lake population belongs to the clupeaformis group. Because of the high degree of overlap between the Chatanika River and Crosswind Lake humpback whitefish gill raker counts, this is not felt to be the case. Further collections may fill in the gaps.

Most humpback whitefish populations in Alaska fall within the range of the Siberian C. lavaretus pidschian which has 16 - 31 gill rakers. The Siberian and Alaskan complex may consist of more than one species. Further research will be needed to clarify the relationship of Alaskan populations having gill raker counts over 23. It is felt that the species name C. pidschian should be used as suggested by McPhail and Lindsey (1970).

Distribution

Almost all whitefish species are found in brackish and freshwater lakes and both slow- and fast-moving streams. The round whitefish is usually a stream fish and not found in an estuarine situation.

Whitefish distribution data in the literature and in past Federal Aid reports are of little value, as the identification is considered incorrect. A problem associated with determining the presence of whitefish is their movement into and out of a given lake or stream.

Generally speaking, the Arctic cisco has a coastal distribution in Alaska from Demarcation Point through the Beaufort, Chukchi, and Bering seas to the Bristol Bay area. It is primarily a fish of estuarine areas and seldom found far inland; however, in late August, 1970, five males with mature sex products were taken in the Yukon River at Fort Yukon (approximately 1,100 river miles from the Bering Sea). No theory as to their spawning grounds can be advanced. Russian authors report that some populations of Arctic cisco in Siberia migrate upstream to spawn, but most spawn in the delta areas.

The least cisco has the same general distribution as the Arctic cisco, but is also widely distributed throughout the Interior. It is especially abundant in numerous lakes where it is a very important item in the diet of pike, lake trout, burbot, and sheefish. The least cisco is usually found in water of lower salinity than the Arctic cisco.

The broad whitefish is widely distributed in the Arctic sections of Alaska. It is found: in the Chukchi and Bering Sea drainages; in the Yukon River and its tributaries; and the Porcupine and Koyukuk rivers. It is widespread in the Minto Flats region of the Tanana River drainage, but apparently rare farther upstream. It is common in the entire Kuskokwim River system. Broad whitefish are absent from the Copper and Susitna river drainages.

The humpback whitefish is the most widely distributed of any whitefish in Alaska. It is found over the North Slope, the Chukchi and Bering Sea drainages, the entire Yukon and Kuskokwim river drainages, the Bristol Bay area, and also the Copper, Susitna, and Alsek river drainages. The humpback whitefish is found in many different habitats and these environments have been responsible for the tremendous variation found within the species. It is found in brackish water, lakes, slow-moving streams, and fast-flowing streams. It has anadromous populations and landlocked populations. The humpback whitefish meets with and is finally replaced by C. lavaretus in the Ob River basin in Siberia. C. lavaretus has in excess of 50 gill rakers in northern Europe. The humpback whitefish meets with the allied species C. clupeaformis of the Great Lakes somewhere in the vicinity of the Yukon Territory and British Columbia.

The round whitefish is most abundant in streams with gravel bottoms. It is distributed across the North Slope, the Brooks Range, Seward Peninsula, and the drainages of the Yukon and Kuskokwim rivers. In Bristol Bay it is replaced by the closely related species, the pygmy whitefish, P. coulteri. The round whitefish is sometimes found in lakes such as Salmon Lake on the Seward Peninsula and Crosswind Lake near Glennallen.

## Age and Growth

An age and growth study was conducted on humpback whitefish and least cisco taken in August and September, 1968, at the Chatanika River weir near the Elliott Highway bridge. These are Minto Flats fish on a spawning migration up the Chatanika River. The length-frequency distribution of 199 humpback whitefish and 147 least cisco sampled from the weir are given in Figures 2 and 3, respectively. Data for males and females were combined as there was little difference in their length distribution. Female least cisco averaged slightly longer. All least cisco females under 32 cm (two) and all males under 26 cm (two) were immature. All humpback whitefish examined were in spawning condition.

A sample of 104 humpback whitefish and 164 least cisco was aged and their lengths back calculated to determine age, growth, longevity, and age at sexual maturity. Data for humpback whitefish are presented in Table 9, data for least cisco in Table 10.

The least cisco spawning migration up the Chatanika River from the Minto Flats is composed of fish from age groups II (age 2+) to VIII. The weight range of cisco taken at the weir was 225 - 2,500 gm. Males first become mature at age II and the majority are mature by age III. Length at maturity for males is 28 - 30 cm at a weight of 225 - 375 gm. The largest male taken in the Chatanika River was a 38 cm specimen of age group VI.

Female least cisco begin to mature at age III, but most mature at age IV. Length at maturity is 32 - 34 cm at an average weight of 0.5 kg. Females evidently live longer than males as five females of age VII and three of age VIII were taken. The largest female taken was 44.5 cm long and weighed 2.2 kg.

The average length and weight range of the sport catch of least cisco both by spearing and snagging in the upper Chatanika River is 35 - 36 cm and 0.7 - 0.8 kg. In addition to their sport value, young least cisco are important prey species for sheefish, pike, and burbot in the Minto Flats.

Minto Flats least cisco grow rapidly and reach sexual maturity at an earlier age than any other Interior Alaska fish. Cohen (1954) reported that least cisco near Point Barrow reach 23 cm at age VI and reach a maximum size of 31 cm (age XI). The least cisco, C. albula, is one of the most important commercial fish in East Siberian rivers where up to 10,000 centners (1,000,000 kg) are taken annually (Mikhailov, 1958). In the Ob River they seldom exceed 50 gm in weight and in the Kolyma and Indigirka rivers, they obtain maximum weights of 350 gm.

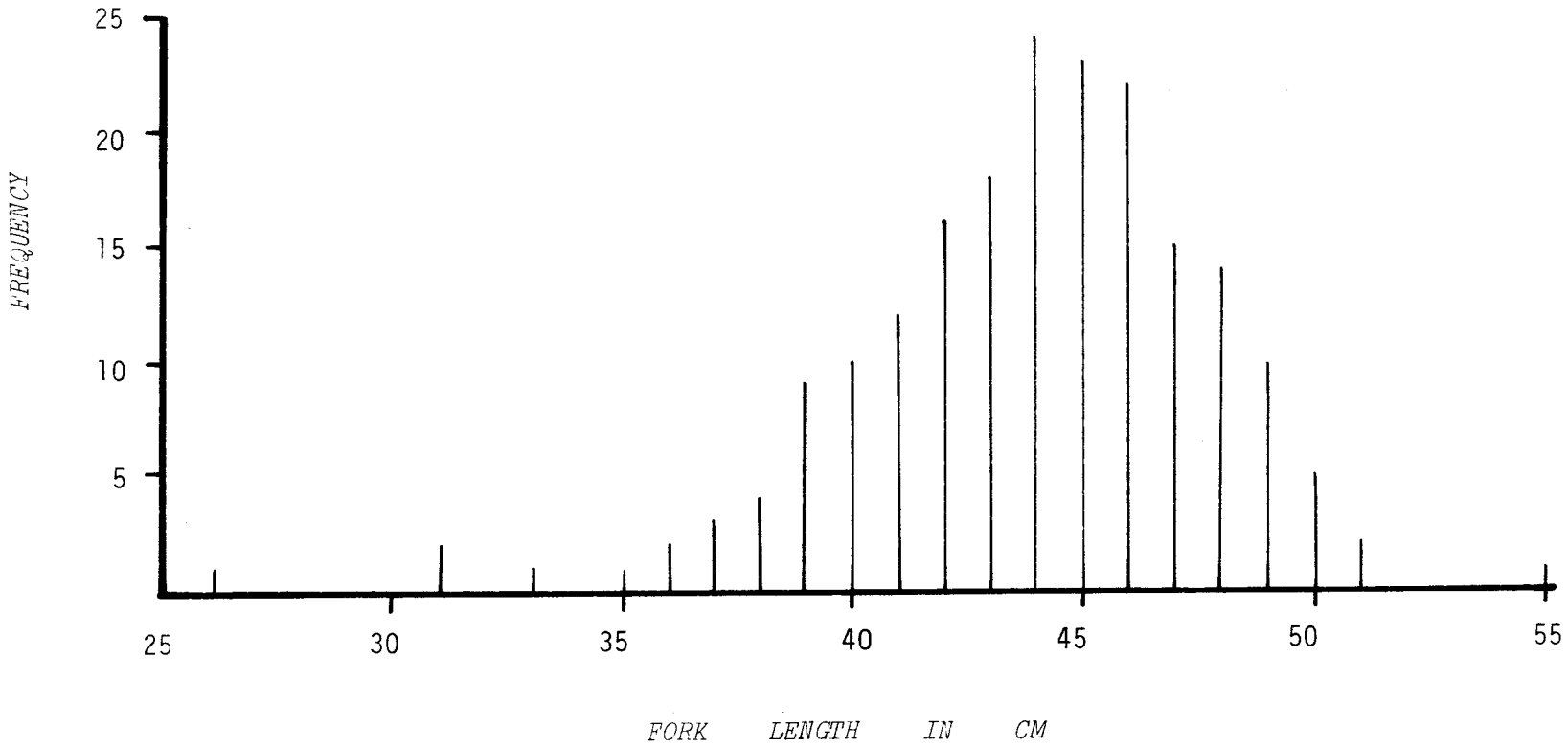


FIGURE 2 LENGTH FREQUENCY DISTRIBUTION OF 199 HUMPBACK WHITEFISH FROM CHATANIKA RIVER, ALASKA.

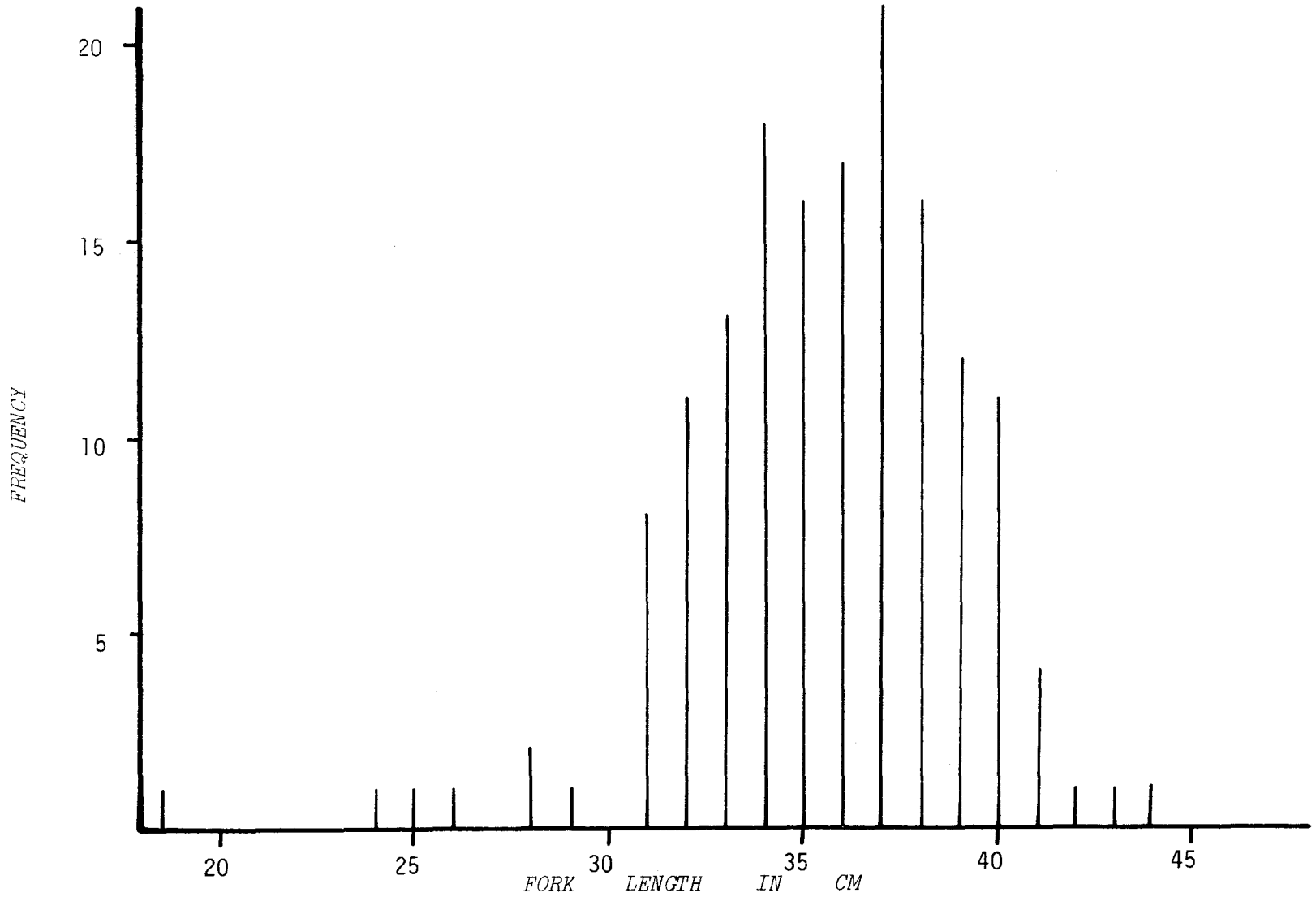


FIGURE 3 LENGTH FREQUENCY DISTRIBUTION OF 147 LEAST CISCO FROM CHATANIKA RIVER, ALASKA. FISH LESS THAN 30 CM ARE IMMATURE.

TABLE 9 Calculated Length at End of Each Year of Life of Humpback Whitefish, Upper Chatanika River, 1968.*

| Age at Capture | N | Mean Fork Length at End of Each Year of Life in mm | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $L_1$ | $L_2$ | $L_3$ | $L_4$ | $L_5$ | $L_6$ | $L_7$ | $L_8$ | $L_9$ | $L_{10}$ | $L_{11}$ | $L_{12}$ |
| IV | 11 | 127 | 211 | 266 | 317 | | | | | | | | |
| V | 17 | 119 | 207 | 269 | 320 | 371 | | | | | | | |
| VI | 20 | 121 | 193 | 255 | 317 | 368 | 406 | | | | | | |
| VII | 23 | 123 | 181 | 241 | 293 | 339 | 382 | 414 | | | | | |
| VIII | 22 | 124 | 187 | 236 | 281 | 330 | 377 | 412 | 441 | | | | |
| IX | 6 | 124 | 187 | 238 | 288 | 343 | 387 | 416 | 445 | 464 | | | |
| X | 1 | 96 | 168 | 226 | 290 | 345 | 364 | 406 | 425 | 450 | 471 | | |
| XI | 3 | 112 | 177 | 247 | 292 | 334 | 383 | 410 | 439 | 463 | 486 | 507 | |
| XII | 1 | 110 | 210 | 264 | 313 | 360 | 400 | 430 | 460 | 480 | 500 | 516 | 532 |
| Mean length, all age groups | | 120 | 194 | 249 | 301 | 349 | 385 | 415 | 442 | 465 | 486 | 512 | 532 |

*Fish were on spawning migration and all were mature (sexes combined).

TABLE 10 Mean Back Calculated Length for Least Cisco taken in Upper Chatanika River, 1968.*

| Age at Capture | N | Mean Fork Length at End of Each Year of Life in mm | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $L_1$ | $L_2$ | $L_3$ | $L_4$ | $L_5$ | $L_6$ | $L_7$ | $L_8$ |
| I | 1 | 134 | | | | | | | |
| II | 6 | 116 | 227 | | | | | | |
| III | 38 | 117 | 223 | 282 | | | | | |
| IV | 72 | 120 | 213 | 272 | 322 | | | | |
| V | 27 | 121 | 208 | 264 | 314 | 348 | | | |
| VI | 12 | 125 | 203 | 256 | 299 | 335 | 365 | | |
| VII | 5 | 114 | 189 | 247 | 305 | 343 | 370 | 390 | |
| VIII | 3 | 127 | 192 | 244 | 280 | 321 | 357 | 384 | 410 |
| Mean length, all age groups | | 120 | 208 | 261 | 304 | 337 | 364 | 387 | 410 |

*Sexes combined.

Growth of Minto Flats humpback whitefish is more rapid than growth of Tikchik Lake (Bristol Bay) (Yanagawa, 1967) and Colville River humpback whitefish (Roguski and Winslow, 1970). The humpback whitefish is an important commercial fish in Siberian rivers but is slower growing than Minto Flats fish. Berg (1948) gives the length of six-year-old fish from the Ob, Yenesei, Kolyma, and Sibircha rivers as 30 - 31 cm. Length at age XII was 41 cm for the Sibircha River and 45 cm for the Yenesei River. Age of spawning humpback whitefish from the Chatanika River ranged from IV - XII. Again males begin maturing a year before females. Most humpback whitefish over 10 years of age were males. The majority of humpback whitefish spawning in the Chatanika River are of ages VII and VIII and have a length of 43 - 45 cm. Mean weight of these fish is 1.2 kg. The sport catch in the upper Chatanika River is composed of fish of this size range.

Few Chatanika River humpback whitefish exceed 10 years of age and age XII is probably close to the maximum. Colville River humpback whitefish reach 16 to 17 years of age (Roguski and Winslow, 1970).

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